

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is divided into three parts. The first part will quantitatively analyse all references published in the field of library and information science (LIS) relevant to artificial intelligence, knowledge-based systems and expert systems. The second part will provide definitions and describe applications of expert systems in LIS. The third part of this chapter will focus on expert systems work in cataloguing and problems faced by cataloguers especially in the area of conference proceedings.

2.2 QUANTITATIVE ANALYSIS OF THE REFERENCES

A scan of a few major online reference sources in the field of LIS retrospective from June 1997 was conducted to retrieve articles in English relevant to artificial intelligence, knowledge-based systems and expert systems. These online reference sources are as follows :

- (i) LISAPlus (Library and Information Science Abstracts)
- (ii) ERIC (Educational Resources Information Centre)
- (iii) INSPEC
- (iv) COMPENDEX
- (v) DAO (Dissertations and Abstracts Online)

In addition to the articles retrieved through the above sources, a manual search of the bibliographies present in the following review articles proffered some relevant articles not found in the online reference sources :

- (i) Poulter, Alan, Morris, Anne, and Dow, Julie. 1994. LIS professionals as knowledge engineers. *Annual Review of Information Science and Technology (ARIST)*. 29 : 305 - 350.
- (ii) Hawks, Carol Pitts. 1994. Expert systems in technical services and collection management. *Information Technology and Libraries*. 13(3) : 203 - 212.
- (iii) Morris, Anne. 1991a. Expert systems for library and information services - a review. *Information Processing and Management*. 27 (6) : 713-724.
- (iv) Drenth, Hilary J., Morris, Anne, and Tseng, Gwyneth. 1991. Expert systems as information intermediaries. *Annual Review of Information Science and Technology (ARIST)*. 26 : 113 - 154.

Furthermore, the printed version of *Library Literature* was also searched. This study eventually chose 1958 as the starting point, since the earliest article discovered in the manual search through the bibliographies discussed the automatic creation of literature abstracts using artificial intelligence architecture was published in 1958. As the investigation into the literature began in July 1997, June 1997 is the cut-off date for this study.

The overall strategy involved in the online search was using keywords: (artificial intelligence or knowledge based systems or expert systems) and (library and information science). The results were then limited to English language publications

only. It is necessary to state here that, as is typical with most computer searches, there are no guarantees to retrieving "every" relevant reference available on a topic. The results retrieved in this study are no exception. The retrieved articles which amounted to a total 422 references were then entered into a database and coded into different categories that represent broad subject areas. **Table 2.1** categorises the retrieved references on expert systems in LIS according to the types of sources and 10 year bands.

Table 2.1 References Retrieved According to Types of Sources

YEAR TYPES OF SOURCES	50s	60s	70s	80s	90s	TOTAL	%
Journal Articles	1	1	5	135	132	274	65
Conference Proceedings	-	-	-	60	19	79	19
Articles in books	-	1	-	12	23	36	9
Dissertations	-	-	1	11	7	19	4
Books	-	-	1	5	8	14	3
TOTAL	1	2	7	223	189	422	100

Out of the 422 references, 274 (65%) references are from journals whereas 79 (19%) references are from conference proceedings. These conferences are inclusive of the International Online Information Meetings, the National Online Meetings, the American Society for Information Science (ASIS) Annual Meetings, the proceedings of the Annual Clinic on Library Applications of Data Processing, and Informatics proceedings.

In contrast to conference papers and journal articles, no books were retrieved from the online sources. There were, however, a few books referred to in the

bibliographies which are found to be relevant (Lancaster and Smith, 1992; Morris, 1992; McDonald and Weckert, 1991; Alberico and Micco, 1990; and Ahuri and Riggs, 1990). The lack of books that cover the use of artificial intelligence and expert systems in the field of LIS could be due to the fact that artificial intelligence and expert systems are relatively new in this field. This accounts for more conference papers and journal articles published than books, indicating the immaturity of AI and ES applications in LIS (Hsieh and Hall, 1989). Also, the online sources used to retrieve the references for this study emphasise journal articles as their selection policies.

Table 2.2 shows a breakdown of the references according to the various subject areas and years they were published in. In an effort to categorise the references, it was necessary to differentiate articles that discussed mainly expert systems and artificial intelligence and touched minimally on library expert systems under the subject area of Expert Systems and Artificial Intelligence. Articles that discussed the applications of expert systems in libraries without specialising on any area in particular were classed under Library and Information Science (general). Finally articles that concentrated mainly on a particular function of the library was classed respectively under the various function, such as cataloguing, abstracting, etc.

Table 2.2 indicates that out of the 422 articles, 232 (55%) articles discussed issues regarding public services especially information searching and retrieval and reference services. The area of information searching and retrieval includes peripheral areas

Table 2.2 Number of References Retrieved According to Broad Subject Areas

SUBJECT AREA	Number of references retrieved						
	50s	60s	70s	80s	90s	TOTAL	%
Expert Systems and Artificial Intelligence	-	-	-	5	7	12	3
Library and Information Science (general)	-	1	-	32	34	67	15
Cataloguing and Classification	-	-	1	28	41	70	17
Public Services (Reference Services, Information Search and Retrieval and Document Delivery)	-	-	5	141	86	232	55
Abstracting and Indexing	1	-	1	13	10	25	6
Acquisitions and Collection Development	-	-	1	2	13	16	4
TOTAL	1	1	8	221	191	422	100

like information storage, interfaces to online retrieval, online searching, etc. The next most active area is ES applications in cataloguing and classification with 70 (17%) followed by articles on abstracting and indexing 25 (6%). It is probably not surprising that ES applications in online search and retrieval covers almost half of the literature as the technology of computerised online searching and retrieving is similar to that of artificial intelligence and hence lends itself well to this new technology (Hsieh and Hall, 1989). Cataloguing would seem the next obvious area to explore with expert systems and artificial intelligence as its dependence on AACR2 rules could make it easily adaptable to an automated manipulation.

Figure 2.1 shows that since the onset of artificial intelligence in the mid 60s, the literature on artificial intelligence and its peripheral areas and its application in the area of LIS only took off in the late 70s, gradually increasing from the year 1979 onward, peaking between the year 1987 and 1992 after which literature in this area

gradually declined. This decline in output of literature can be explained by the fact that research in LIS development may have concentrated on certain domains only such as intelligent front-ends and gateway software that may have reached its peak of development. Furthermore, the development of ES in other library domains such as management decision support assistant, collection development and advisors in narrower areas of library science have not caught on.

Figure 2.1 Number of References on Expert Systems Applications in LIS by Year

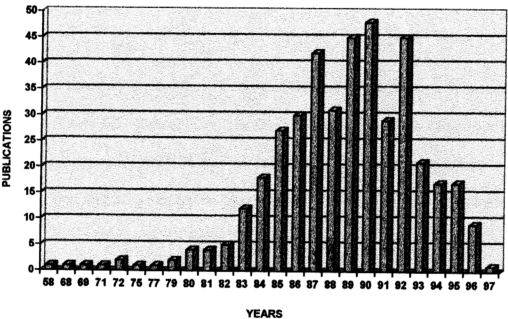


Table 2.3 shows the frequency of journal titles that contribute articles in the area of expert systems applications in LIS. There are a total of 274 journal articles contributed by 110 journal titles out of the 422 references. This data was then verified against Bradford’s Law of Scatter.

Bradford's Law of Scatter is defined as follows: If a large collection of papers is ranked in order of decreasing productivity of articles relevant to a given topic, three zones can be marked off, such that each zone produces one-third of the total of relevant articles. The first, the nucleus zone, contains a small number of highly productive journals, say n_1 ; the second zone contains a larger number of moderately productive journals, say n_2 ; and the outer zone a still larger number of journals with low productivity, say n_3 . The law of scatter states that

$$n_1 : n_2 : n_3 = 1 : \alpha : \alpha^2$$

where α is a constant.

If the 274 articles are divided into three equal zones, we get $274/3 = 91$ articles in each zone. **Table 2.3** indicates that in the first zone the figure in the cumulative total that comes close to 91 is 95. Hence, we take the figure 95. Corresponding to this figure, we find that in the first zone 5 most productive journals have contributed to these 95 articles. Doubling the figure 91 we get 182 articles. From **Table 2.3**, this corresponds to 28 journals. Hence the second zone sees 23 journals contributing 88 articles, each contributing between 2 to 6 articles. In the same way, the third zone has 82 journals contributing 91 articles.

Tabulating the figures of the three zones indicate that the periodicals are in the ratio of 5 : 23 : 82 i.e. 1 : 4.6 : 16.4. Therefore the value of α is approximately 5. As can be seen from **Table 2.4**, the scattering of articles partially follows Bradford's law. In the analysed data, the value of α as 5 means that the nucleus zone contains 5 highly

Table 2.3 Ranking of Journals Contributing to Expert Systems in LIS

Rank	Journal Title (n = 110)	No. of Articles (n = 274)	Cumulative total	%
1	Information Processing & Management	39	39	14.2
2	Journal of the American Society for Information Science	24	63	22.9
3	Information Technology and Libraries Library Software Review	11	85	31.0
4	The Reference Librarian	10	95	34.6
5	Journal of Information Science Online Online Review	6	113	41.2
6	Annual Review of Information Science and Technology (ARIST) Expert Systems for Information Management Library Hi Tech	5	128	46.7
7	Aslib Proceedings Cataloging and Classification Quarterly Computers in Libraries J of Documentation Library Resources and Technical Services Program Reference Services Review	4	156	56.9
8	Bulletin of the Medical Library Assoc. Canadian Journal of Information Science College and Research Libraries Journal of Education Library & Information Science Library Acquisitions : Practice & Theory Microcomputers for Information Management RQ	3	177	64.5
9	ACM Transactions on Information Systems Communications of the ACM Education for Information Encyclopaedia of Library & Information Science Expert Systems IEEE Expert Illinois Libraries International Classification Library Science with a Slant to Documentation and Information Studies Science and Technology Libraries Technical Services Quarterly Wilson Library Bulletin	2	201	73.3
10	Others with only one article in each	73	274	100.0

productive journals. These journals are: *Information Processing and Management* (which contributed 39 articles), *Journal of the American Society for Information*

Science (24 articles), *Information Technology and Libraries* (11 articles), *Library Software Review* (11 articles) and *The Reference Librarian* (10 articles).

Table 2.4 Scattering of Articles on Expert Systems in LIS in Journals

Zone	No. of Articles	No. of Journals (observed value)	No. of Journals (calculated value)
1 st	95	5	5
2 nd	88	23	25
3 rd	91	82	125

2.3 DEFINITIONS OF EXPERT SYSTEMS

The term expert systems is loosely and ambiguously used as is evident from the literature. Weiss (1995) states three definitions of expert systems: (a) it is a computer system that emulates human intelligence; (b) it is a computer system that automates a task that requires human expertise; and (c) it is a computer system that models human thought processes.

Yaghmai and Maxin (1984) and Morris (1992) considers expert systems to be computer-based systems that use knowledge and reasoning techniques to solve problems that would normally require human expertise. Knowledge obtained from experts and from other sources such as textbooks, journal articles, manuals and databases is entered into the system in a coded form, which is then used by the system's inferencing and reasoning processes to offer advice on request.

The Encyclopedia of Library and Information Science (1993) associates expert systems with rule-based systems. Furthermore, expert systems are often seen to

comprise a set of heuristic rules that capture in some way the knowledge of an expert (Weiss and Kulikowski, quoted by O Cathain, 1987), and if one has a complete and efficient engine for handling rules, it is possible to produce expert systems. However, Davidson, Davidson and Ruberg (1988) warn that one must be careful as the term expert systems can actually be applied to few systems, since most systems do not have an expert level of performance, and their information base does not allow them to behave like consultants. They say that the term knowledge based systems is more applicable for describing most systems today.

Hawks (1994) explains that knowledge-based systems are the broad category of systems that use some knowledge to perform their functions. They need not use either heuristics or artificial intelligence techniques in performing their tasks. Intelligent systems are a subset of knowledge-based systems. They display intelligent behaviour, but not necessarily at the level of a human expert. Expert systems are considered a more specific category and use heuristics to perform tasks previously done by human experts. In essence, a well-developed expert system should provide the same answers that an expert would give when approached with a particular problem.

2.4 EXPERT SYSTEMS IN LIBRARY AND INFORMATION SCIENCE

The *Encyclopedia of Library and Information Science* (1993) states that with the use of programming languages such as LISP or PROLOG, and expert system shells available, librarians are actively producing library expert systems. The earliest review

article found on expert systems and their applications in LIS has 59 references (Vickery and Brooks, 1987a). However this article concentrated on the areas of document retrieval and reference as these were the two areas where work was most prolific then. Smith's (1987) article on the use of artificial intelligence and information retrieval is by far the most comprehensive with 204 references. Drenth, Morris and Tseng (1991) in their article that also covered mainly expert systems in information search and retrieval however provided only 141 references. A review article by Morris (1991a) which tried to be comprehensive in covering six areas of LIS contained 103 references. The latest review article that could be located is by Poulter, Morris and Dow (1994) which has 144 references. However their article was concerned with knowledge engineering and did not attempt to summarise progress in specific application areas within LIS. The following review of literature on expert systems applications in LIS is based on 415 articles broken down into the following divisions: expert systems in LIS (general); expert systems in technical services (which include classification); expert systems in public services (which include reference services, information search, retrieval, and document delivery); expert systems in abstracting and indexing; and expert systems in acquisitions, collection development and preservation. Expert systems in cataloguing is treated separately because of its direct relevance to this study.

2.4.1 EXPERT SYSTEMS IN TECHNICAL SERVICES

The primary reason for developing expert systems for technical services is to bring the improvements that technology can provide to bear in cataloguing and

classification tasks (Hawks, 1994). Literature shows too that more effort has been expended in developing expert systems applications for technical services (Drenth and Morris, 1992; Fenly, 1992; Dabke, Thomas and Shams, 1992; Jeng, 1995). Research has progressed especially in cataloguing and classification. The complexity of each of these tasks and the availability of guidelines for performing them have spurred the development of expert systems for technical services.

2.4.1.1 CLASSIFICATION

Classification is a difficult function to capture in an expert system. While there are guides to determine classification numbers and subject headings, there are no strict rules available, and the relationships between objects and classes are often ambiguous. Among some of the systems that have been developed for patent and book classification are by Sharif (1988), Valkonen and Nykanen (1991), Cosgrove and Weimann (1992), Gopinath and Prasad (1994), Savic (1994), Gowtham (1995).

In 1986, Paul Burton conducted an explanatory and investigative research at the University of Strathclyde in the United Kingdom, aiming to assess the merits of various ways of knowledge representation and to assess the suitability of expert systems in classification. The research resulted in a prototype expert system that was able to advise a Dewey classification number based on the information provided by the user and to justify the reasoning and to explain why the expert system asked certain questions. Following the research, OCLC developed a prototype expert system, Cataloguer's Assistant, and tested it at the Carnegie-Mellon University

(CMU) to reclassify CMU's mathematics and computer science collection. The experiment tried to answer some research questions such as the knowledge representation, the navigation tools, the search capabilities, and the various ways of displaying data.

CUTT-x, an expert system for automatic assignment of Cutter numbers (Savic, 1996) was developed using Microsoft ACCESS relational database in the MS-Windows personal computer based environment. On evaluation, it was found that the system performed well for the International Civil Aviation Organisation Library. Savic noted that larger libraries require more complex cutttering and therefore a more complex CUTT-x system.

ShelfPro, developed by Drabenstott, Riestter and Dede (1992) addresses shelflisting. Shelflisting is concerned with assigning a book number, as opposed to the class mark portion of the call number, to an item.

The Defence Metallurgical Research Laboratory in Hyderabad, India developed an expert system for classification of technical documents using the Universal Decimal Classification (UDC) schedule for metallurgy as the knowledge base and the UDC classification as its rule base (Gowtham, 1995). Some benefits of the expert system are that : it interacts with the classifier making them conform to the route suggested by the classification scheme; it alerts the classifier to the minor variations in the scheme thus avoiding overlooking them; it leads to consistency in class number

generation; and it ensures that the classifier has incorporated all the concepts of the subject in the class number, by leading him / her through all the groups, which is not possible in the manual UDC scheme. **Table 2.5** lists named and unnamed ES developed for classification found in published literature.

Table 2.5 Expert Systems in Classification

NAME	DEVELOPER	YEAR
*	Burton, Paul	1986
*	Sharif, Caroline A Y	1988
*	Valkonen, Pekka and Olli Nyakanen	1991
*	Cosgrove, S J and J M Weimann	1992
*	Liu, Songqiao	1993
*	Gopinath, M A and A R D Prasad	1994
*	Gowtham, M S	1995
CLOD-x	Savic, Dobrica	1994
CUTT-x	Savic, Dobrica	1996
ShelfPro	Drabenstott, Karen Markey, Leslie C Riester and Bonnie A Dede	1992

* Unnamed systems

2.4.2 EXPERT SYSTEMS IN PUBLIC SERVICES

2.4.2.1 REFERENCE SERVICES

The first experiments in the automated provision of reference services began in the 1960s. A method of characterising biographical reference books for the purpose of retrieving those most likely to answer particular biographical queries was developed at the University of Chicago (Weil, 1968) while at Berkeley REFSEARCH was based on a careful analysis of the characteristics of reference questions, such as how topics are qualified, and the functions of the works used to answer them (Meredith, 1971). As a result, REFSEARCH embodied a more realistic model of the reference process.

One of the earliest systems developed to answer routine enquiries was REFLES1 (Reference Librarian Enhancement System) developed at the University of California, Los Angeles (UCLA) in the late 1970s (Bivins and Palmer, 1980). It was a microcomputer-based system for in-house data files of information about library facilities, services and operations, and also gave details of specific types of library materials along with some 'how to use' comments on the catalogue, abstracting services, etc. An enhanced version of REFLES1, called REFLINK, was subsequently produced at Linköping University in Sweden (Bivins and Eriksson, 1982).

In 1983 Purdue University Undergraduate Library in Indiana introduced its Reference and Information Station for public use (Smith, 1989). It was found that most of the questions received at the reference desk could be grouped into nine categories, with another nine sub-categories, and these were used in the design of a menu-based system which runs on both Apple and IBM microcomputers. Another microcomputer-based, menu-driven ready reference system known as the Information Machine was produced at the University of Houston Library (Fadell and Myers, 1989). Graphics are used to illustrate floor layouts to help with directional enquiries. Currently work is being done on an expert system that would be developed for selecting reference works and it will be linked to the Information Machine.

The Online Reference System (ORS) (Chisman and Treat, 1984) was designed to provide menu access to MARC records of 1000 reference works in the science library of the Bowling Green State University in North Carolina by subject (using

broad categories based on the Library of Congress Classification), type of material, or course name and number.

A prototype reference system, DISTREF, for students taking courses by distance learning offered by Charles Sturt University in Australia was designed to provide assistance in the choice of search terms by using 'discipline maps' (McDonald and Weckert, 1990). DISTREF is an expert system that is intended to link to a union catalogue on CD-ROM of the holdings of a wide range of libraries in New South Wales.

The Workstation for Information Seekers planned by Micco and Smith is intended to provide access to thesauri and, like DISTREF, to maps of terms (Micco and Smith, 1989). The system is used for searching reference works that would be stored, along with the thesauri and catalogues of various collections, on a CD-ROM jukebox. Search strategies employing expert systems techniques, including user modelling are used to narrow the search space.

POINTER was one of the first systems to be used routinely. It was developed at the State University of New York at Buffalo for providing assistance in finding US government publications where regular staff members were not available (Smith, 1986; 1989). Two types of searches are catered for by POINTER: enquirers wanting specific documents are given their SuDoc numbers; subject searching is also possible

but there was difficulty in devising a suitable conceptual framework for the organisation of the menus.

The Patent Information Assistant (which is also explained in the section under Experts for Retrieval in Subject Domains) was developed at the University of Austin because of the time consuming and repetitive nature of patent enquiries (Ardis, 1990). It is menu driven and allows searches by patent number, inventor's name, assignee name, class/subclass, and keyword. Access is provided to external databases chosen according to the type of search.

The expert system Reference Expert (Bailey and Gunning, 1990; Gunning, 1992) has a knowledge base that is based on interviews with the library reference staff. Reference and library systems staff, working as knowledge engineers, clearly recognised the experts' difficulty in articulating their knowledge and the limits of the software in representing the complexity of that knowledge. To encourage ongoing input, they developed prototypes, left them in the work area for experimentation with a log for comments, and on the basis of this feedback from the experts, incrementally extended the knowledge base. Three prototypes of Reference Expert were developed; one using KnowledgePro, another using VP-Expert, and the third using PDC Prolog (Bailey, 1992). In the end, Prolog was chosen for the working model since it gave better performance and control over the finished product than the shells. Although the Prolog version was faster than the shells, the size of the knowledge

base (over 230kbytes) slowed the system to unacceptable levels until a method of reducing the system load was devised.

Online Reference for Expertise in Opera (ORFEO) recommends sources to answer questions about operas. It contains a knowledge base developed from one major bibliography of 700 items, plus some items added by Gerber (1992). This system is based on the "given (the information known by the client) and wanted (the information required by the client)" notion of reference theory and is purely a prototype. Another subject specific reference expert system was AquaRef. It was designed by the U.S. National Agricultural Library to give assistance with a limited range of frequently asked reference questions about aquaculture (Haufman, 1989). AquaRef was designed as a result of experiences with an earlier expert system Answerman (Waters, 1986). Answerman was one of the first expert advisory systems with links to external databases produced also by the National Agricultural Library. It was created for demonstration purposes using the shell 1st-class. Its domain is ready reference enquiries in agriculture that it answers by giving details of relevant books, sometimes including specific page numbers, or by allowing the user to search a database such as Agricola.

ChemRef, a guide to reference sources in chemistry, was developed at Nova University in Florida (Sarangapani, 1990). When compared with the performance of experienced reference librarians, it was found that ChemRef was capable of operating

at a level comparable to or better than library staff. However the system has a tendency to recommend a greater number of titles

Smith (1992) used the shell EXSYS to develop a production rule-based advisor to help library assistants locate appropriate reference material to answer questions on New Zealand. NZRef, like ORFEO, is based on the notion that a reference question is composed of a given and a wanted. Smith judged the rule structure to be a limited but useful way to represent knowledge about sources. One difficulty he noted was that certain combinations of rules used for particular reference tasks created unsuitable recommendations and, to suppress these, special rules had to be added to the knowledge base. Another difficulty was that not all members of a class of information sources could have a general set of rules applied. He argues that frames would provide better representation where differences are important.

REFSIM, an expert system designed by Parrott (1989) used frames as a model for the reference process. Each dialogue with a client was driven by the need to fill in slots in types of frames. Types of transactions were directional, holdings, ready reference, and substantive. There were also frames for the librarian and the client. REFSIM was designed to simulate both the librarian and the enquirer so that it can be used not only for answering queries but also as a tutorial system for instructing users, including novice librarians. REFSIM is the successor to the Online Reference Assistance system (ORA) (Binkley and Parrott, 1987) which was a menu-driven system but of a more complex nature than most referral systems. In enquiries about

the library's holdings, ORA would use an expert system for interpreting citations in cases where the enquirer could not distinguish properly between the different fields in the bibliographic reference (Parrott, 1986).

Harley and Knobloch (1991) built Government Documents Reference Aid (GDRA) to investigate the value of an expert system to enhance user access to these publications at Stanford University Library. The second and third phases of their project involved an investigation and evaluation of the available expert system shells.

The University Library Gronigen in the Netherlands, COWOG (Centre for research on Higher Education) and PICA (the Dutch Organisation for Library Automation), developed a computer assisted bibliographic reference and advisory system - CoBRA (Bosman, 1994). It is an expert system that advises users of the University Library when they want to execute a search for literature on a certain subject. It also produces custom-made guides to the literature in the library.

Another standalone expert system, MAKLUM, was developed for the University of Malaya Library using the expert system shell CRYSTAL 4.50 running on DOS (Zainab and Nor Eliza, 1996). MAKLUM was designed to provide answers to general reference enquiries relating to library facilities, services, regulations, loans, membership, location of items, and public amenities.

Table 2.6 Expert Systems in Reference Service

NAME	DEVELOPER	YEAR
*	Weil, C B	1968
*	Cavanagh, Joseph M A	1987
*	Richardson, John	1989
*	Butkovitch, Nancy J, et al.	1989
*	Vedder, Richard G, et al.	1989
*	Metzger, Paul	1993
Answerman	Waters, Samuel T	1986
AquaRef	Haufman, Deborah	1989
ChemRef	Sarangapani, Chet	1990
CoBRA/RUG	Bosman, F	1994
DISTREF	McDonald, Craig and John Weckert	1990
Government Documents Reference Aid (GDRA)	Harley, Bruce L and Patricia J Knobloch	1991
Information Machine	Fadell, Jeff and Judy E Myers	1989
KARMA	Liebowitz, Jay and Christine Letsky	1996
MAKLUM	Zainab Awang Ngah and Nor Eliza Mohd Zaid	1996
NZRef	Smith, Alastair	1992
Online Reference Assistance (ORA)	Binkley, R D and James R Parrott	1987
Online Reference System (ORS)	Chisman, J and W Treat	1984
ORFEO	Gerber, Brian	1992
PLEXUS	Vickery, Alina and Helen M Brooks	1987
POINTER	Smith, Karen F	1986
RAS	Carande, R	1989
Reference and Information Station	Smith, Dana E	1989
Reference Expert	Bailey, Charles W and Kathleen Gunning	1990
Reference Expert	Bailey, Charles W	1992
REFLES1	Bivins, K T and R C Palmer	1980
REFLINK	Bivins, K T and L Eriksson	1982
REFSEARCH	Meredith, J C	1971
Refsearch	White, H D and D Woodward	1990
REFSIM	Parrott, James R	1988
Sourcefinder (SOFI)	Stalker, J C	1996
Workstation for Information Seekers	Micco, Mary H and Irma Smith	1989

* Unnamed systems

Sourcefinder (SOFI) is an expert system consisting of a database of annotated reference sources, using the Nota Bene software, which serves as a support for

reference services at the reference desk of the Main Library at Ohio State University (Stalker, 1996). SOFI is used by new reference librarians as a training aid, by experienced librarians in unfamiliar subject areas and has the potential to be used at times and places where reference librarians are unavailable. **Table 2.6** provides a list of named and unnamed ES for reference service reported in published literature.

2.4.2.2 INFORMATION SEARCH AND RETRIEVAL

The area of most activity, having the longest history and the largest number of research and development activities, is work on expert search intermediaries. The purpose of much of the work is to make online systems directly accessible to end users without the need to rely on human intermediaries (Smith, 1987). This section considers expert intermediary systems in the context of both their role in relation to end users - that of search advisor, intelligent front end, or intelligent intermediary - and their role in the search process (as experts in search formulation, for example).

2.4.2.2.1 Search Advisors

Search advisors are expert intermediary systems that aim not only to assist or advise end users but also to train them in online searching. The search advisors developed to date focus on search tactics, particularly on monitoring the progress of a search and on selecting or revising search terms.

The first of these systems was Individualised Instruction for Data Access System (IIDA) (Meadow, 1979; Meadow, Hewett and Aversa, 1982a; 1982b). It was

designed to help scientists and technicians learn online bibliographic searching of DIALOG in order to obtain a few good references rather than attempting complex searches. IIDA was reactive, providing assistance only when the user made a mistake or when aid was specifically requested. In addition to dealing with syntactic errors, IIDA detected and offered advice on null sets retrieved, repetitive use of commands, unused sets, rapid shifts in search objectives, and the overuse of a single approach to a search.

Meadow continued his work on expert advisory systems for online bibliographic searching with the Online Access to Knowledge (OAK) project. He developed OAKDEC, available as a menu option in OAK (Meadow, 1988). OAKDEC was rule based and used factors such as the set size, the number of records reviewed by the user, and the user's evaluation of records to arrive at a recommendation.

Another search advisor was the Intelligent Database Enquiry Assistant (IDEA) developed by Houghton, Rich and Bass (1987). It comprised a Tutor, an Advisor, and a User Question Handler. The Tutor presented text describing the system and an interactive lesson. The Advisor offered advice on the choice of database and keywords, giving general advice such as "try more general terms," and suggesting alternative terms. The User Question Handler dealt with questions of why, what, and how, such as "How do I narrow a search?"

2.4.2.2.2 Intelligent Front Ends

Expert intermediaries that act as intelligent front ends to online services are closely related to advisory systems. These front ends intervene in the search process to a greater or lesser extent, their primary aim being to provide trouble-free access to online services. Early intelligent front ends focused on search tactics, especially those concerned with search formulation and the selection of terms. Presently, this approach has been broadened to support a fuller intermediary role, incorporating knowledge relating to the selection of databases and search strategies.

Marcus and Reintjes (1981) developed the Connector for Networked Information Transfer (CONIT) to aid end-user searching in overcoming the complexity and diversity of online search systems. CONIT gave user-friendly access to several hosts by means of a simple common-command language. CONIT also included some limited facilities for reformulating searches, such as automatically rerunning a search with exact terms only when too many references were retrieved. EXPERT took a more active role in the search process as compared to CONIT suggesting suitable databases and prompting the user for terms and synonyms before translating them into Boolean search statements (Marcus, 1981). OASIS also followed this "worksheet" approach to online searching, one of its main objectives being to reduce the amount of time spent online (Williams, 1984, 1985; Williams and Goldsmith, 1982). Both EXPERT and OASIS could suggest tactics for broadening or narrowing a search according to the number of postings found.

The evolution of expert systems as intelligent front ends was furthered by the use of natural-language user interfaces. The Information Retrieval Natural Language Interface (IR-NLI) (Guida and Tasso, 1983) aimed to provide an intermediary system that could both comprehend a user's search request and identify the underlying information need. The EURISKO (Barthes, Frontin and Glize, 1987) prototype also used natural-language processing which searched scientific databases on the Questel and Cedocar online services. Though EURISKO could not suggest suitable search terms unlike IR-NLI, it came closer to fulfilling an intermediary role because it used knowledge derived from human intermediaries to suggest suitable databases according to the query subject and the types of document required.

IR-NLI II (Brajnik, Guida and Tasso, 1990) incorporates user modelling into a domain-independent bibliographic retrieval expert system. Domain knowledge is supplied separately by an online thesaurus. The expert system clarifies its model of the query, proposes terms to expand the query, and comments on the users search strategy. No automatic query reformulation is done.

Fox (1987) developed CODER using μ -Prolog (a logic programming language used for knowledge representation) to build a complex, multitiered system for document retrieval. CODER, like IR-NLI, used a natural language interface. Lucarella and Morara (1991) have attempted to extend the representative power of Prolog by building with it a document retrieval system, FIRST (Fuzzy Information Retrieval SysTem), which uses fuzzy instead of Boolean logic.

Tome Searcher, an intelligent front end which uses a natural language interface for searching online databases in mainframe hosts in the fields of electrical / electronic engineering, computer science, and information technology, was launched commercially in 1988. (Vickery, 1988). However it did not prove to be viable commercially.

2.4.2.2.3 Intelligent Intermediaries

Intelligent intermediaries refer to systems developed to investigate intelligent approaches to the information retrieval process rather than interfaces to existing online services. These systems have integrated document collections and do not use the exact-match retrieval techniques found in conventional retrieval systems. Some of these systems draw on knowledge of users and search tactics to interpret and elaborate search requests. Others use knowledge of the concepts represented in a document base to effect retrieval and so avoid many of the problem-solving tasks associated with human information intermediaries. Although they do not incorporate intermediary knowledge, these systems suggest new approaches to the intermediary function that might be integrated into expert intermediary systems.

The intelligent information retrieval systems that incorporate intermediary expertise have distributed expert systems architecture. The Intelligent Interface for Information Retrieval (I³R) (Croft and Thompson, 1987) had experts for user modelling and modelling the search request, a domain knowledge expert that could infer related

search concepts, a search controller that selected one of two available retrieval techniques, a browsing expert, and an explainer.

The Composite Document Expert/Extended/Effective Retrieval (CODER) system, another distributed expert system was developed by Fox (1987) as a testbed for analysing, filing, and retrieving documents with widely differing contents and structures, such as those generated within electronic mailing systems. CODER was unique in that it could be distributed over several machines and that it included a temporal reasoning expert to identify, parse, and represent query expressions relating to time spans or dates.

Other efforts in intelligent information retrieval concentrated on knowledge-intensive retrieval techniques. In the IOTA information retrieval system, which incorporates a natural language interface, developed by Chiaramella and Defude (1987), every component of a document - title and fragments of text - was indexed by noun phrases organised into a hierarchical tree representing the document content. Retrieved references were evaluated, and if judged inappropriate, IOTA set a goal, such as "reduce the number of references", and reformulated the query.

Browsing is another knowledge-intensive retrieval technique in which the relationships among documents, terms, and other bibliographic information are represented as a network, which the searcher can examine and use to identify the

documents required, as in the THOMAS system (Oddy, 1977). A browsing interface is also planned for the KIWI system.

The Improving Library Subject Access (ILSA) prototype expert system was developed at Indiana University of Pennsylvania using an object oriented multimedia user interface with two databases : one with 100,000 MARC records and the other with 20,000 additional records enhanced with table of contents data (Micco, 1994). Items are grouped into subject clusters consisting of the classification number and the first subject heading assigned. Every other distinct keyword in the MARC record is linked to the subject cluster in an automated natural language mapping scheme, which leads the user from the term entered to the controlled vocabulary of the subject clusters in which the term appears. The use of a hierarchical classification number (DDC) makes it possible to broaden or narrow a search result.

Rule-Based Retrieval of Information by Computer (RUBRIC) was another knowledge-intensive information retrieval system (McCune, et al., 1985; Tong, et al., 1985, 1987); a commercial version of it is now available as Topic. Topic provides for Boolean searching and for browsing by hypertextual links. The RUBRIC system is one of the few systems to provide intelligent assistance for full-text searching. The Empty Software for Common Knowledge Transfer (ESOCKS), an expert system shell for document retrieval developed by Hitachi (Yasunobu, et al., 1989), uses a technique similar to that of Topic. On finding documents, ESOCKS assigns each one a relevance value so the user can decide which documents to display.

2.4.2.2.4 Experts In Query Formulation

The Comprehensive Information Retrieval Computer Environment (CIRCE) was one of the first systems to address the problem of elaborating the search topic prior to formal specification of the search (Aragon-Ramirez and Paice, 1985). The user entered a set of terms describing a query, and these were matched against thesaurus terms. The thesaurus resides in the knowledge base. When some degree of match was found, terms were displayed for evaluation of their relevance.

In frame-based systems, such as the environmental pollution expert EP-X (Krawczak, et al., 1985), CoalSORT (Monarch and Carbonell, 1987), and the PLEXUS referral system on gardening (Vickery, et al., 1987; Vickery and Brooks, 1987b), topics, associated concepts and terms are represented explicitly, reflecting, in effect, the subject-based knowledge that human intermediary brings to the interpretation of search topics. In PLEXUS, for example, entering a query activated a set of frames describing the search topic; these were used to identify any ambiguities and elicit the information needed to complete the problem description. PLEXUS was written in Turbo Pascal and Prolog, although the former was chosen for the final prototype because : (1) at the time the programs were being written, no Prolog compiler was available for microProlog, so run-times were very slow; (2) loading the Prolog databases was very slow; and (3) interfacing of microProlog and Pascal needed a significant amount of specialised work that was too costly. These problems were exacerbated by the growth from an original projection of a rule base of approximately 250 rules to over 1,000 rules, including a number of rule sets.

The CoalSORT prototype reported by Monarch and Carbonell (1987) used a frame-based semantic network of concepts in the subject domain of catalyst applications in coal liquefaction. Users constructed search statements by browsing terms in the network; each term had an associated frame that held details such as the term's meaning, its generic name, examples of its use, and whether it was used to index documents. This structure took the guesswork out of choosing relevant search terms since the user could display associated information as he browsed terms. It was also possible to browse terms within retrieved documents and use them to refine the search.

To measure the success of a search and decide whether to reformulate the search statement, intermediaries frequently look at the number of references retrieved, the "correct" number being determined by user requirements. The reformulation of search strategies according to the number of references retrieved has been addressed by a number of systems, including those developed by Marcus (1981), Williams (1984, 1985), Barthes, Frontin and Glize (1987), Gauch and Smith (1989), and Sormunen (1989). The tactics used in all these systems were independent of the subject domain and focused on broadening or narrowing the search strategy.

2.4.2.2.5 Experts For Database Selection

The problem of choosing suitable sources of online information has only recently received much attention. Among some of the systems that have been developed are by Marcus's work with automatic database selection in CONIT (1981), and

EURISKO that ranks databases on the basis of subject coverage (Barthes, Frontin and Glize, 1987). The expert selectors (Thornburg, 1987; Morris, Tseng and Newham, 1988; and Drenth, Tseng and Morris, 1991) drew on the expertise of human intermediaries in selecting databases. Wang (1990) has developed a database selector for business queries. Trautman and von Flittner (1989) used printed guides to online sources for their expert systems knowledge with the purpose of developing a stand-alone aid to databases rather than to investigate the database-selection problem.

Kiwinet is an experimental prototype for advising on selection of databases on the Kiwinet online service. It is a very small system built to permit comparison of the commercial shells EXSYS and ESIE. Smith (1991) chose these because both had been used for previous LIS applications. EXSYS was more flexible in that it allowed multiple recommendations of reference sources ranked by a probability value, whereas ESIE could return only one reference source recommendation. In providing explanations to the user, EXSYS displayed the current rule under consideration and the facts collated to date, while ESIE simply used a trace mechanism to show the thinking to date. Both provided for backward chaining through the knowledge base.

Sajjad Zahir and Chew (1992) also developed a prototype for the selection of online databases named Online-Expert. The results of their evaluation of the system compared favourably with those of experts using traditional searching, considering

that the system contained only 60 of a possible 150 databases available to the experts.

Drenth and Morris (1992) chose a shell for their proposed expert system CIDA (Company Information Database Advisor) to select online sources for business enquiries. They report that in addition to the many desirable development features of shells, they are cost effective, their developers offer good support, and future clients are likely to have the hardware requirements to run a shell-based system. In a later paper, Morris, Drenth and Tseng (1993) discuss the knowledge engineering problems resulting from slow execution speed and severe memory problems. They needed to edit the knowledge base severely, reorganise the knowledge representation, and rewrite several external files.

2.4.2.2.6 Experts For Retrieval In Subject Domains

A number of expert systems for assisting searches in specific subject domains have been developed. These include NP-X (natural products chemistry), EP-X (environmental pollution), CANSEARCH (cancer therapy), GENSEARCH (biomedical genetics) and Coach - the expert searching system designed to help users of the Grateful Med front end software to improve MEDLINE search and retrieval capabilities (Kingsland, 1993). Pollitt says that the strength of this knowledge lies in the fact that domain-specific knowledge can be applied to improve the system's overall performance.

CANSEARCH (Pollitt, 1984, 1987) is one of the earliest expert systems for bibliographic retrieval. The expert system contains knowledge of a single domain, cancer, rather than search strategies in general. During the query reformulation process, the expert system guides the searcher through a hierarchy of menus.

The Patent Information Assistant (Ardis, 1990) was developed jointly by two programmers and two patent reference librarians, who used an iterative approach. The team has identified interface screens that need rewriting, and the developers wish to add a module to explain the differences between trademarks and patents. Ardis also comments that the system never tires, is never irritated, can often give users customised information in a more individual way than the staff has time to provide, which suits the confidential nature of many of the inquiries.

EP-X (Krawczak, Smith and Shuter, 1987; Smith et al., 1989) is a prototype knowledge-based system that assists users in conducting bibliographic searches of the environmental pollution literature. This system makes extensive use of domain knowledge, represented as hierarchically defined semantic primitives and frames. The user enters a query as a list of keywords and the system interacts with him to suggest possible broadening or narrowing operations. **Table 2.7** gives a summary of all systems being developed in the domain of search and retrieval.

Table 2.7 Expert Systems in Information Search and Retrieval

NAME	DEVELOPER	YEAR
*	Marcus, Richard S and J Francis Reintjes	1981
*	Williams, Philip W and G Goldsmith	1982
*	Meadow, Charles T, Thomas T Hewett and Elizabeth S Aversa	1982
*	Guida, Giovanni and Carlo Tasso	1983
*	Pollitt, A Steven	1984
*	Smith, Philip J and Mark Chignell	1984
*	Thompson, Roger H and W Bruce Croft	1985
*	Zarri, Gian Piero	1985
*	Crawford, R G and H S Becker	1986
*	Desalvo, Daniel A and Jay Liebowitz	1986
*	Borgman, Christine L	1986
*	Watters, R C, M A Shepherd and W Robertson	1987
*	Morris, Anne, Gwyneth M Tseng and Godfrey Newham	1988
*	Yasunobu, Chizuko, et al.	1989
*	Gauch, Susan and John B Smith	1989
*	Trautman, Rodes and Sara von Flittner	1989
*	Drenth, Hilary J, Gwyneth Tseng and Anne Morris	1991
*	Blackadder, Alistair	1990
*	Gauch, Susan and John B Smith	1990
*	Khoo, Christopher S G and Danny C C Poo	1990
AGRIRES	Konig, Eckehard	1990
ARGON	Patel-Schneider, Peter F, Ronald J Brachman and Hector J Levesque	1990
CANSEARCH	Pollitt, A Steven	1990
COACH	Kingsland, L C	1990
CODER	Fox, Edward A	1990
DIALECT2	Bassano, J C, M Braunworth and W Mekaouche	1990
EP-X	Krawczak, Deborah A, et al.	1990
Eurisko	Barthes, Christine, J Frontin and Pierre Glize	1990
European Research Letter	Ford, Nigel	1991
FIRST	Lucarella, D and R Morara	1991
I ² R	Croft, Bruce W and Roger H Thompson	1987
IDEA	Houghton, Tony, Clive Rich and Andrew Bass	1987
ILSA	Micco, Mary H	1994
INFOS	Obermeier, Klaus K and Linda E Cooper	1984
IOTA	Chiararella, Y and B Defude	1987
KIWINET	Smith, Alastair	1991
LOOK	Thornburg, Gail E	1987
MenUSE	Pollitt, A Steven	1988
Moss	Morris, Anne, Gwyneth Tseng and Kathryn P Walton	1989
OAKDEC	Meadow, Charles T	1988
OL'SAM	Toliver, D E	1982
Online-Expert	Sajjad, Zahir and Chew Lik Chang	1992
Patent Information Assistant	Ardis, Susan B	1990
RUBRIC	McCune, B P, et al.	1985
SAFIR	Florian, D	1987
Tome Searcher	Vickery, Alina	1988

* Unnamed systems

2.4.2.3 DOCUMENT DELIVERY

There were only two references found pertaining to document delivery. These two researches have been done recently. The first by Brown (1993b) and the other by Abate (1995). Brown describes the use of expert systems technology at Raytheon Company's equipment division to co-ordinate requests for specifications and standards documents with purchases made through the acquisitions unit. She further discusses the development of a knowledge base using the shell program VP-Expert. Abate reports on an expert system which was developed for document delivery decision making in the library of a law firm using the expert system shell, VP-Expert. Table 2.8 indicates the two ES developed for document delivery.

Table 2.8 Expert Systems in Document Delivery

NAME	DEVELOPER	YEAR
*	Brown, Lynne C Branche	1993
Document Delivery Expert	Abate, A K	1995

* Unnamed system

2.4.3 EXPERT SYSTEMS IN ABSTRACTING

Most of the research in abstracting has been concerned with abstracting papers from learned journals and conference proceedings. The first reported experiment on automatic abstracting was in 1958 by Lahn. Since then, other systems have been developed by DeJong (1983), Kuhlen (1984), Lebowitz (1986), Husk (1988), Black and Johnson (1988), Johnson (1988), Rau, Jacobs and Zernik (1989), Black (1990), Jacobs and Rau (1990), Paice (1990), and Endres-Niggemeyer, (1995).

DeJong (1982) produced the FRUMP system that analyses newspaper articles using frame-based techniques. The articles are scanned and data are automatically fed into various slots within frames. Scripts are then used to generate summaries of the information held in the relevant frames. Another system, which reports on corporate mergers and acquisitions, was developed by Rau, Jacobs and Zernik (1989). Known as SCISOR, this system produced a detailed linguistic analysis of a text from which a semantic graph is constructed. Summaries may then be produced using a natural language generator. A similar system was also developed by Hahn and Reimer (1985). Their system TOPIC summarises texts about micro-processor systems.

Table 2.9 lists named and unnamed ES developed for abstracting.

Table 2.9 Expert Systems in Abstracting

NAME	DEVELOPER	YEAR
*	Luhn, H P	1958
*	Kuhlen, Rainer	1984
*	Black, W J and F C Johnson	1988
*	Husk, G D	1988
*	Paice, Chris D	1990
*	Endres-Niggemeyer, B	1995
FRUMP	DeJong, Gerald	1982
RESEARCHER	Lebowitz, M	1986
SCISOR	Rau, L F, P S Jacobs and U Zernik	1989
TOPIC	Hahn, U and U Reimer	1985

* Unnamed systems

2.4.4 EXPERT SYSTEMS IN INDEXING

There has been some progress made in the area of indexing. Humphrey and Miller (1987) produced an "Indexing Aid System" as part of the Automated Classification and Retrieval Program (ACRP) conducted in the Computer Science Branch of the

National Library of Medicine. Other systems that have been developed are by Brenner, et al. (1984), Carande (1988), Bailey, et al. (1989), Purcell (1991), Schuegraf and Bomm (1993), and Ford and Ford (1994).

FASIT (Dillon and Gray, 1983) was one of the first systems to incorporate syntactic knowledge for automatic indexing purposes. The system uses 161 predefined concept forms built around desired combinations of syntactic categories. These concept forms are specified in such a way as to be able to accommodate any unresolved ambiguities present in the text once it has passed through the syntactic categoriser.

The MedIndex system (Humphrey, 1987; 1989) assists indexers to select the most appropriate indexing terms from MeSH, the National Library of Medicine's computerised thesaurus. The system provides prescriptive aids, such as enforcing the rule of specificity that is common to most manual indexing systems, as well as suggestive aids, such as prompting users to fill slots in the frame structures.

Carande (1989) wished to demonstrate to other library staff that a series of subject-specific expert systems could extend the expertise of reference librarians well beyond their specific bibliographic knowledge. He developed INDEXES using the demonstration version of EXSYS that allowed a maximum of 25 production rules but did not govern the number of sources that could be recommended. This limited

prototype assigned probability weightings to possible sources based on their suitability.

Index Expert designed by Bailey, et al. (1989) use frames to represent the bibliographic records of reference sources. The hierarchical structure of the frame allows for efficient representation and maintenance of the knowledge base, which was written in Turbo Prolog, using the Knowledge Base Management system. This allows the use of a fully featured editor to update and to change the knowledge base, which could be reloaded into the system for error checking. Table 2.10 lists named and unnamed ES developed for indexing found in published literature.

Table 2.10 Expert Systems in Indexing

NAME	DEVELOPER	YEAR
*	Brenner, E H, et al.	1984
*	Schuegraf, Ernst J and Martin F van Bomm	1993
*	Ford, Nigel and Rosalind Ford	1994
FASIT	Dillon, M and A S Gray	1983
Index Expert	Bailey, Charles W, et al.	1989
INDEXES	Carande, R	1988
Indexing Aid	Humphrey, Susanne M and Nancy E Miller	1987
MedIndex	Humphrey, Susanne M	1987
WANTED	Purcell, Royal	1991

* Unnamed systems

2.4.5 EXPERT SYSTEMS IN ACQUISITIONS

In their 1989 survey of artificial intelligence and expert systems in libraries, Hsieh and Hall rightly acknowledged that in acquisitions, "there are no set rules to guide the creation of expert systems." Although acquisitions librarians would likely argue that there are some set rules, the basic assumption is valid (Hawks, 1994). Since

Hsieh and Hall's study, at least two expert systems in acquisitions have been developed and reported in the literature.

The first system is the Monographic Acquisitions Consultant (MAC) which was designed to eliminate the discretionary component in monographic vendor selection, replacing it with a more quantitative decision-making model. The MAC uses the macro capabilities of the spreadsheet Lotus 1-2-3 to allow it to act like an inference engine. The system was also developed to support the library's philosophy of using multiple vendors for monographic ordering (Zager and Smadi, 1992). Zager encountered the classic problem of the expert not always being able to articulate her reasons for making a selection or the factors considered. Hardware problems and the constant need to maintain the knowledge base have precluded the system from being used in production.

The second expert system developed at Pennsylvania State University by Lynne Branche Brown (1993a) determines whether a title requested for order would be received on any of the extensive approval plans maintained by the library. The receipt of books on approval plans is determined by a set of rules called the plan profile, which could be incorporated into an expert system. Once again in this system, the need for continuous maintenance was evident. The system must be updated as changes are made in each profile, as, for example, when publishers are added or deleted (Hawks, 1994). Table 2.11 indicates the two ES developed for acquisitions.

Table 2.11 Expert Systems in Acquisitions

NAME	DEVELOPER	YEAR
*	Brown, Lynne C Branche	1993
Monographic Acquisitions Consultant (MAC)	Zager, Pam and Omar Smadi	1992

* Unnamed system

2.4.6 EXPERT SYSTEMS IN COLLECTION DEVELOPMENT

With the continual increase in number of publications and reductions in materials funding, it is more important than ever to select the best and most relevant material for the library's patrons (Das, 1993; Chakrabarty, 1993). Johnston and Weckert (1990) provide two additional arguments for the capture of collection development expertise in expert systems. First, this expertise could be put to use in smaller libraries that could never afford the services of a full-time human expert (Debrower and Jones, 1991). Second, larger libraries could use the system as a second opinion to improve consistency in the decision-making process. Collection development is also an appropriate domain because perfect results are not required, nor is it clear what perfect results would be in this area (Hawks, 1994).

Monograph Selection Advisor was developed by Steven Sowell (1989) at Indiana University. Sowell selected a narrow subject field - classical Latin literature - because its scope was primarily limited to the works of a few dozen writers and secondary works about those writers and their works. A series of questions was developed based on the following factors : subject; research and teaching needs; selection sources; and budgetary constraints. Based on the user's responses to these questions

the system would make one of five recommendations : must be bought, should be bought, can be bought, should not be bought, or more information is needed. The problem here is that the selection criteria are not clearly delineated within the literature, and experts use heuristics extensively with few measures of their success beyond meting expressed demands for materials.

Shortly after Sowell's endeavour, Selection Advisor was developed by Johnston and Weckert (1990, 1991) in Australia and uses six categories of selection criteria (in declining order of importance) : subject, intellectual content, potential use, relation to collection, bibliographic considerations, and language. Issues within these categories are grouped into first, second, and third priorities. The system interacts with the user through a series of thirty questions for each book or journal being considered for purchase. Using PROLOG programming language (because it was more flexible than a shell), the system evaluates responses to these questions and recommends either purchase or rejection of the title.

Journal Expert Selector (JES) was developed by Roy Rada (1987), editor of *Index Medicus*, and colleagues to capture the expertise of human journal selectors at the National Library of Medicine who were making decisions as to which journals should be indexed in *Index Medicus*. The main criteria of JES included (1) composition of the journal, (2) producers of the journal, (3) information in articles, and (4) authors of articles.

The Bibliographer's Workstation, developed by Meador and Cline (1992) at Southwest Missouri State University, represents the use of a hypertext tool rather than an expert system. The system models the four-step collection decision process : identification of material, evaluation, selection (or rejection), and acquisition. Each stage relies on different sets of data. The data are organised into four groups : (1) bibliographic data, such as the library's local OPAC; (2) critical and contextual data, such as collection development policies and accreditation standards; (3) financial data, such as the library's materials budget allocations; and (4) commercial data, such as vendor databases.

Table 2.12 Expert Systems in Collection Development

NAME	DEVELOPER	YEAR
*	Das, P	1993
Bibliographer's Workstation	Meador, John M and Lynn Cline	1992
Gift Assistant	Debrower, Amy and Deanna T Jones	1991
JES	Rada, Roy, et al.	1987
Monographic Selection Advisor	Sowell, Steven L	1989
Selection Advisor	Johnston, Mark and John Weckert	1990

* Unnamed systems

The expert system of Debrower and Jones (1991) called Gift Assistant for collection management was built using a shell called Intelligent Developer. This shell allowed both production rules and frames to be used and also provided links to HyperCard for building graphical user interfaces. Gift Assistant, which determines whether the library should accept a particular donation, is an expert system that is well received by the professional staff in a division of the Johns Hopkins University Library. It conserves staff time and ensures that valuable gifts are processed more quickly.

Table 2.12 lists named and unnamed ES developed to aid collection development processes.

2.4.7 EXPERT SYSTEMS IN PRESERVATION

Preservation activities are almost an entirely unexplored territory in the expert systems area. The only evidence that can be found of development in this area is a system known as CALIPR, marketed by the California State Library Foundation. This needs-assessment instrument provides some of the expertise of a preservation consultant "to help access, quantify, and prioritise the preservation needs of your collection." (quoted from Hawks, 1994).

2.5 EXPERT SYSTEMS IN CATALOGUING

According to Davies (1986), cataloguing is a possible domain of application for expert systems because it has certain characteristics: there are recognised experts, the experts are demonstrably better than amateurs, the task takes an expert a few minutes to a few hours, the task is primarily cognitive, and the skill is routinely taught to neophytes. The 1980s saw a huge increase in activity along with the popularity of expert systems and knowledge-based systems. Three streams of researchers emerged: those interested in developing systems to give advice on the application of rules (advisory programs), those concerned with record creation, and those more absorbed with automating the whole process (Morris, 1992).

2.5.1 Expert Systems As Advisory Programs

One of the earliest attempts at producing an advisory system for cataloguing was by Black and colleagues (1985). They built two versions of a system called HEADS using the shells ESP Advisor and SAGE. The system was supposed to enable users to browse through the text of the code or to obtain advice regarding a particular field in a record, or to work through the complete cataloguing procedure. However, both shells had poor string-handling facilities and thus were unable to support certain rules, such as those dealing with hyphenated surnames.

Around the same time, Eyre (1986) at the Polytechnic of North London developed a system that dealt with the forms of names of persons. The knowledge base was derived from Chapter 22 of AACR2. The system was written in PROLOG and was more of an exercise in learning about the language rather than an attempt to design a useful system.

Another example is a limited person-machine interface developed in Wisconsin (Epstein, 1987). This is the MITINET/marc system for microcomputer cataloguing applications. MITINET/marc provides the user with prompts and instructions for entering bibliographic data and translates that information into appropriate MARC format.

CATALYST was another advisory expert system. It was developed by Gibb and Sharif (1988) using the shell ESP Advisor to enable researchers to add canned

explanatory text, so that users could ask for more information to be displayed about terms or menu choices that they did not understand on request. A more detailed and specialised expert system has been produced by Ercegovac (1990) called MAPPER where MAPPER's knowledge base consists of not only the relevant AACR2 rules but also the knowledge of experts in map cataloguing.

MacCat, like MAPPER, developed at the University of California Los Angeles by Maccaferri (quoted by Morris, 1991a) used Apple's Hypercard environment. MacCat is intended for establishing headings, together with their MARC field and subfield codes. Since MacCat is implemented on the Apple Macintosh, full advantage is taken of the mouse and icons for entering data. This makes it more flexible than earlier systems that force the user to proceed through chains of menus one step at a time. Another system that makes extensive use of windows has been designed by Piotr Murasik (quoted by Davies 1991), of Gdansk University in Poland, called APEX (Access Point EXpert). Written in PROLOG, it was completed early in 1991. Like MacCat, users are allowed short cuts so that they do not have to go through the entire cataloguing procedure to provide a bibliographic record.

CatTutor, a hypertext prototype tutorial for training cataloguers to provide descriptive cataloguing of computer files, was developed by the National Agricultural Library (NAL) and its collaborators. Included in the program are portions of the AACR2, the MARC format for computer files, a glossary, five illustrative bibliographic records accompanied by instructional text, quizzes, and a mastery test.

Evaluators were enthusiastic about computer-assisted training and the machine-readable versions of the AACR2 and MARC format integrated in the program, however they felt that the program must be redesigned to create different paths for different levels of expertise of the users, or it must be directed at a single type of user (Thomas, 1992).

CONFER is an expert system guide built using the expert system shell CRYSTAL. CONFER does not produce a catalogue entry but guides the novice cataloguer to the appropriate AACR2 rules and format of main entry headings for conference proceedings (Zainab, 1991a). An upgrade of the system, called CONFER version 2, was developed under CRYSTAL 4.50 to guide both novice and student cataloguers. It was tested with graduate library science students and was found to be effective in enhancing the trainee cataloguers' learning process in handling conference proceedings documents (Zainab, 1996).

Another aspect of research done in this area is the formation of public knowledge in cataloguing presented in various rules and standards of cataloguing, such as AACR2. Codification of such public knowledge is essential as it serves as the basis on which human heuristics in implementation and interpretation of rules is added (Jeng and Weiss, 1994). An attempt was made by Jeng (1991b) to study the logical structure of such public rules in a knowledge base. She argues that rules for description as they are presented and grouped in the mnemonic structure of Part I of AACR2 cannot be used as logical base for codification. The rules must be further studied and broken

down into logical condition / action pairs before they are codified into the knowledge base. To this extent, Smith, et al. (1993) developed an expert system called the AACR2EXPERT which provides an algorithmic approach to the use of AACR2.

Meador and Wittig (1991) conducted a study to determine and then to compare the cores of AACR2 rules used in assigning access points for random samples of monographs in chemistry and a subset of economics. They found that there were differences in the usage of AACR2 rules for assigning main entry to books in the two disciplines under study. They suggested that the creation of a subset of rules is necessary if an expert system for automatic cataloguing is to be built. Furthermore, the weighting of certain rules according to the discipline to which the catalogued material belongs would aid the development of a more sophisticated system, one that required less decision-making on the part of the cataloguer.

2.5.2 Expert Systems For Record Creation

Attempts to integrate the advisory approach with software that could produce catalogue records were first undertaken by Davies and James (1984). They conducted the Exeter Project that investigated the technical feasibility of encoding parts of the AACR2 rules concerning the selection of the main-entry. The project, although not successful due to the failure of the program that reallocates space, was the first attempt to develop an expert systems that can give advice on the application of cataloguing rules (James, 1983).

Around the same time, Hjerppe, Olander and Marklund (1985) conducted the well-known ESSCAPE (Expert System for Simple Choice of Access Points for Entries) Project in Sweden, which resulted in the creation of two expert systems - ESSCAPE/EMYCIN and ESSCAPE/Expert-Trees. Rather than producing systems for practical use, the aim was to discover issues entailed in the creation of the knowledge base (Hjerppe and Olander, 1985; 1989).

Weiss (1994) reported in his article of the Expert Assistant Project at the National Library of Medicine (NLM). The system was to be designed to assist the human cataloguer in selecting the form of a personal name heading to be used in catalogue records and create the local authority record. The author reported that the NLM did not gain the production expert system that it had originally hoped for due to the reasons reported in the literature.

2.5.3 Expert Systems For Automated Cataloguing

Interest in this area started with Ann M. Sandberg-Fox in 1972 who conducted a pioneer study as her doctoral research at the University of Illinois at Urbana-Champaign. The study addressed the conceptual issues on determining whether the human intellectual process of selecting main-entry could be simulated by computers. It was only a decade later, in the late 1980s when interest in this area picked up again. One research in Germany produced a system called AUTOCAT (Endres-Niggemeyer and Knorz, 1987), which attempts to generate bibliographic records or

periodical literature in the physical sciences that are available in machine-readable form.

Another significant work was undertaken by Weibel, Oskins and Vizine-Goetz (1989). They built a prototype rule-based expert system at OCLC known as "the OCLC Automated Title Page Cataloguing Project" to automate descriptive cataloguing from title pages. The system used OCR techniques and their study reports a success rate of 75% in identifying and interpreting bibliographic data on title pages using visual and linguistic characteristics codified in only 16 rules.

Elaine Svenonius, like Weibel, was concerned with the interpretation of machine-readable title pages of English-language monographs. Her research however focused on the problem of automatically deriving name access points, particularly personal names and corporate names (Svenonius and Molto, 1990). In their study, Molto and Svenonius (1991) propose an algorithm for identifying corporate names by creating a machine-readable corporate name authority file, and matching character string sequences on the title pages with those in authority file. In formulating an algorithm for identifying personal names, they effectively use the initial element cues (i.e., first name, initials, titles) and postname markers (such as punctuation or spacing). The results of their studies show high success rates of more than 84% in identifying both kinds of names.

The QUALCAT (Quality Control in Cataloguing) project at the University of Bradford attempted to apply automated quality control to databases of bibliographic records. Sets of records, putative duplicates, that appeared to be for the same monograph were grouped together and an expert system was used to determine whether they were in fact duplicates, and if so which were the best records (Ridley, 1992; Ayres, 1994). **Table 2.13** lists named and unnamed ES developed to aid the cataloguing process found in published literature.

Table 2.13 Expert Systems in Cataloguing

NAME	DEVELOPER	YEAR
*	Davies, Roy and Brian James	1984
*	Eyre, J	1986
*	Jeng, Ling Hwey	1986
*	Weibel, Stuart, William Oskins and Diane Vizine-Goetz	1989
*	Svenonius, Elaine and Mavis Molto	1990
*	Juliaton Mohd Jawaini	1995
AACR2EXPERT	Smith, David, et al.	1993
APEX	Murasik, Piotr	1991
AUTOCAT	Endres-Niggemeyer, B and G Knorz	1987
CATALYST	Gibb, Forbes and Carolyn Sharif	1988
CatTutor	Thomas, Sarah E	1992
CONFER	Zainab Awang Ngah	1991
CONFER2	Zainab Awang Ngah	1996
ESSCAPE	Hjerppe, Roland, Birgitta Olander and Kari Marklund	1985
Expert Assistant	Weiss, Paul J	1994
HEADS	Black, W J, P Hargreaves and P B Mayes	1985
MacCat	Maccaferri	1991
MAPPER	Ercegovac, Zorana	1990
MITINET/marc	Epstein, Hank	1987
QUALCAT	Ridley, M J	1992
QUALCAT	Ayres, F H	1994
SYNONAME	Siegfried, Susan and J Bernstein	1991

* Unnamed systems

2.6 PROBLEMS IN CATALOGUING CONFERENCE PROCEEDINGS

The organisation and creation of bibliographic records for conference publications is difficult for cataloguers especially if the cataloguer is a novice to standardised rules, such as AACR2 (McGarry and Yee, 1990; Zainab, 1991b). McGarry and Yee distinguished that within the range of conference publications, those identified only by a generic term for a meeting and the name of the sponsoring body pose special problems. Their study focused on what was the most common method of providing a bibliographic description for these types of conference proceedings.

Theoretically, there are four ways to provide main entry for the type described above such as entering the meeting directly, treat it as a subordinate entry, enter the meeting under the holding body, and consider the meeting unnamed and therefore not eligible for corporate body entry but an entry under title. McGarry and Yee found that there is a preference among reference librarians in searching for conference publications under the corporate body holding the meeting, either directly under its own name or subordinately, under the name of a higher body. This preference is also in agreement with the findings by McKinlay (1978).

A study of proceedings of Malaysian conferences held in 1989 and received by the University of Malaya Library indicated that 86.5% are unpublished; 12% are published as collected works mostly under editorship; 1.5% are published abroad; and none are published as serials (Zainab, 1991b). Problems arise in the case when the unpublished version of the conference title or information may or may not appear

on the title page but may be embedded within the text of the introduction, preface or even the back cover of the published document.

Zainab (1991a) goes on to say that the main problem which confronts the cataloguer is the choice of main entry heading and the format which needs to be adopted with consistency which in turn depends on : where to locate the conference statement, the name and format of the conference to be chosen as heading, the necessary information to be presented in a conference heading, and the type of cross-references needed to be given from the variant names of the conference to the heading adopted for the main entry. Bowman (1996) says that in AACR2 a conference must be prominently named in order to qualify for main entry, and in this case it is treated as simply another category of corporate body, so that the general rule for main entry under corporate body also applies.

A further search of the literature to unearth articles on the problems of cataloguing conference proceedings did not prove very productive. Berman (1990), coping with access to conference proceedings, gives a detailed account of the Penn State library's decisions in regard to classification. Monographic, rather than serial, description of conference proceedings complicates sequential shelf arrangement in open stacks as the specific topic of a given conference can vary, and established conferences can split or merge. McGlasson (1983) in her article discusses whether they should be viewed as monographs or periodicals when in published form. Borries (1988) and McKinlay (1978) discusses the nature of conference publications, the problems

peculiar to them in terms of cataloguing and also reviews the different forms of heading used.

This study therefore aims to throw further light on the problems of processing conference proceedings by attempting to map the thought processes of expert cataloguers and develop an appropriate advisor system to aid cataloguers in giving bibliographic description to conference proceedings.

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